The Impact of Climate Variability on the Health of Older Americans

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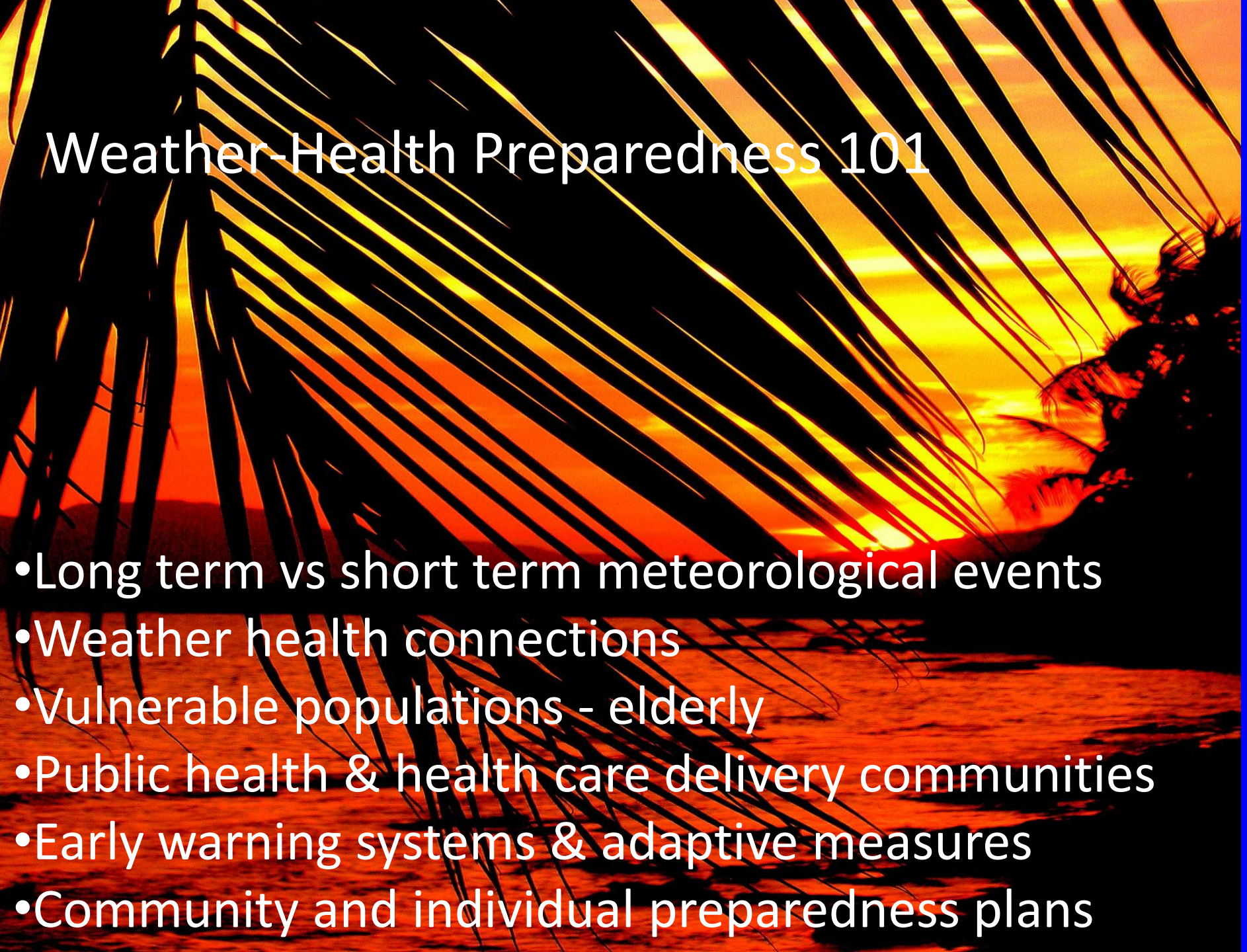
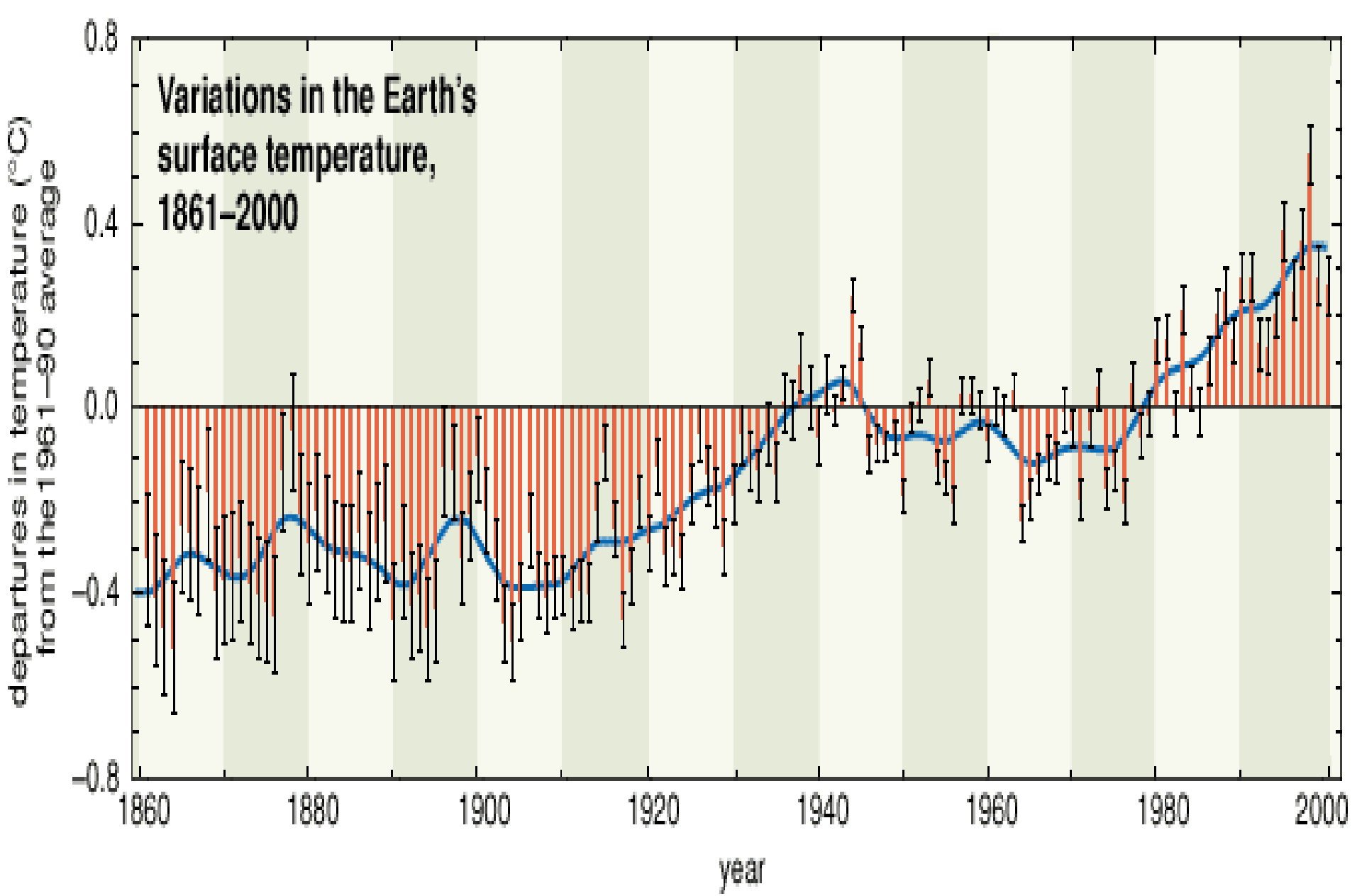
Assistant Professor of Emergency Medicine
Emory University School of Medicine



Weather-Health Preparedness 101

- Long term vs short term meteorological events
- Weather health connections
- Vulnerable populations - elderly
- Public health & health care delivery communities
- Early warning systems & adaptive measures
- Community and individual preparedness plans



Source: Intergovernmental Panel on Climate Change; World Meteorological Organization; United Nations Environment Programme

Weather – Climate - Health

" In discussing "climate change and health" we must distinguish between the health impacts of several meteorological exposures: weather, climate variability and climate change."

WHO – Climate Change and Human Health – Risk and Responses

Weather – Climate – Climate Variability

Weather – Continuously changing condition of the atmosphere occurring on a time scale from minutes to weeks.

Climate – Average state of the atmosphere, and associated characteristics of underlying land or water, in a particular region, spanning at least several years.

Climate Variability – Is variation around average climate, including seasonal variations and large-scale regional cycles in atmospheric and ocean circulations.

WHO – Climate Change and Human Health – Risk and Responses

Weather – Climate - Health

Weather

- Short term planning
- Operational focus
- Treatment.

Climate

- Long term planning
- Policy focus
- Prevention

Figure 3.1. Pathways by which climate change affects human health (modified from reference 2)

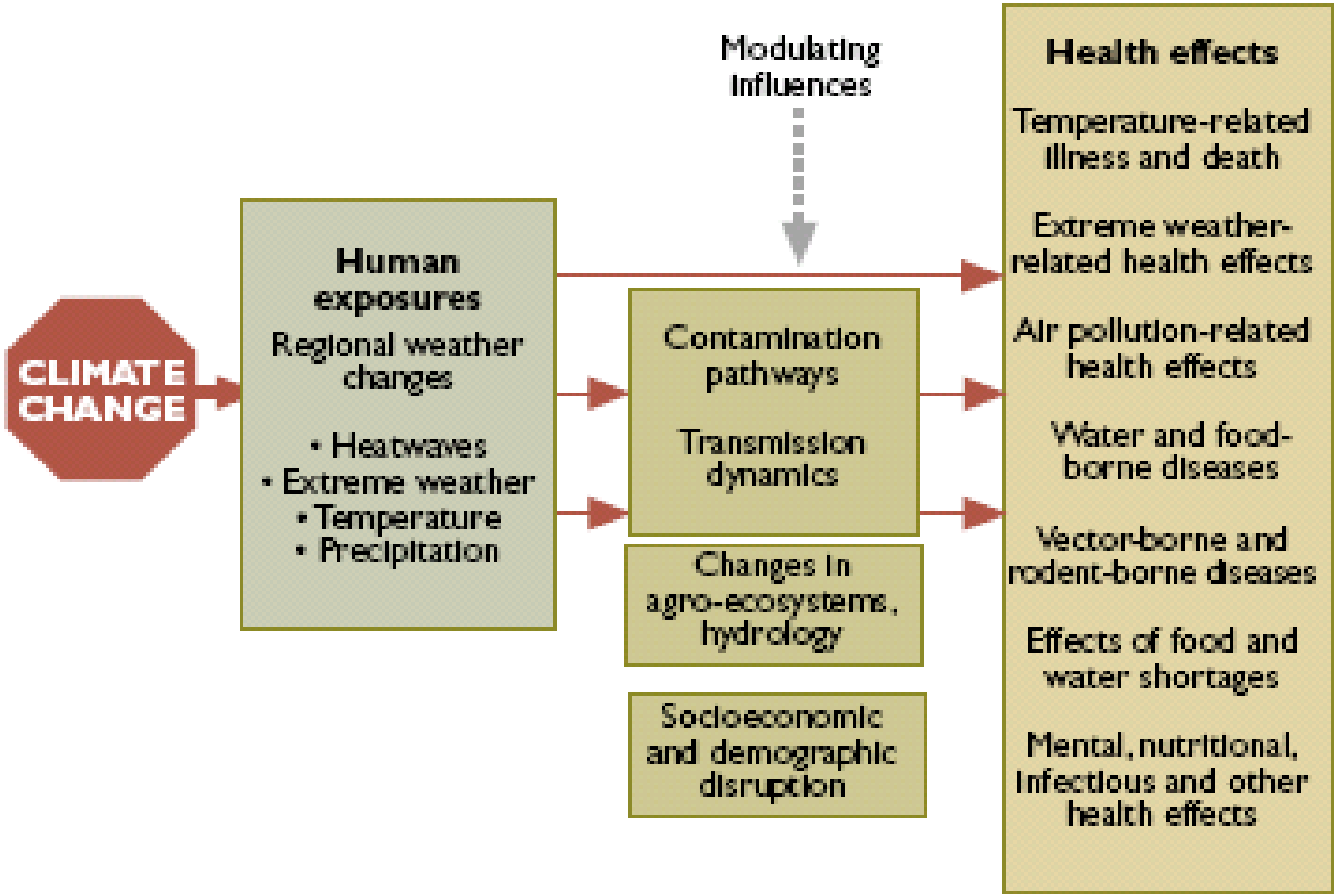


Figure 1

Which Diseases are

Climate Sensitive?

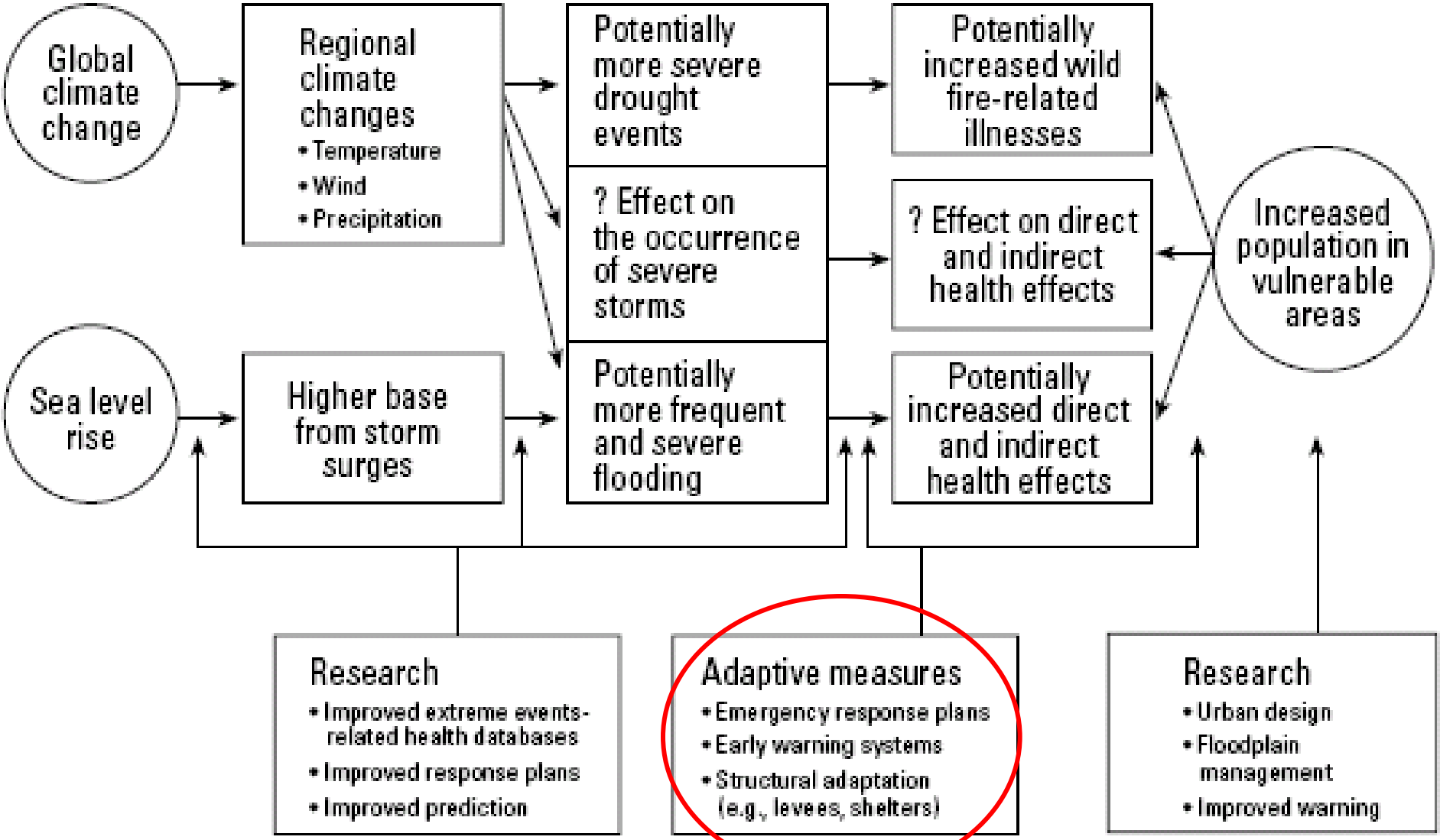


Figure 1. Extreme weather events-related health effects of global climate change. ?, uncertainty. Data from National Clinical Data Center (*86*).

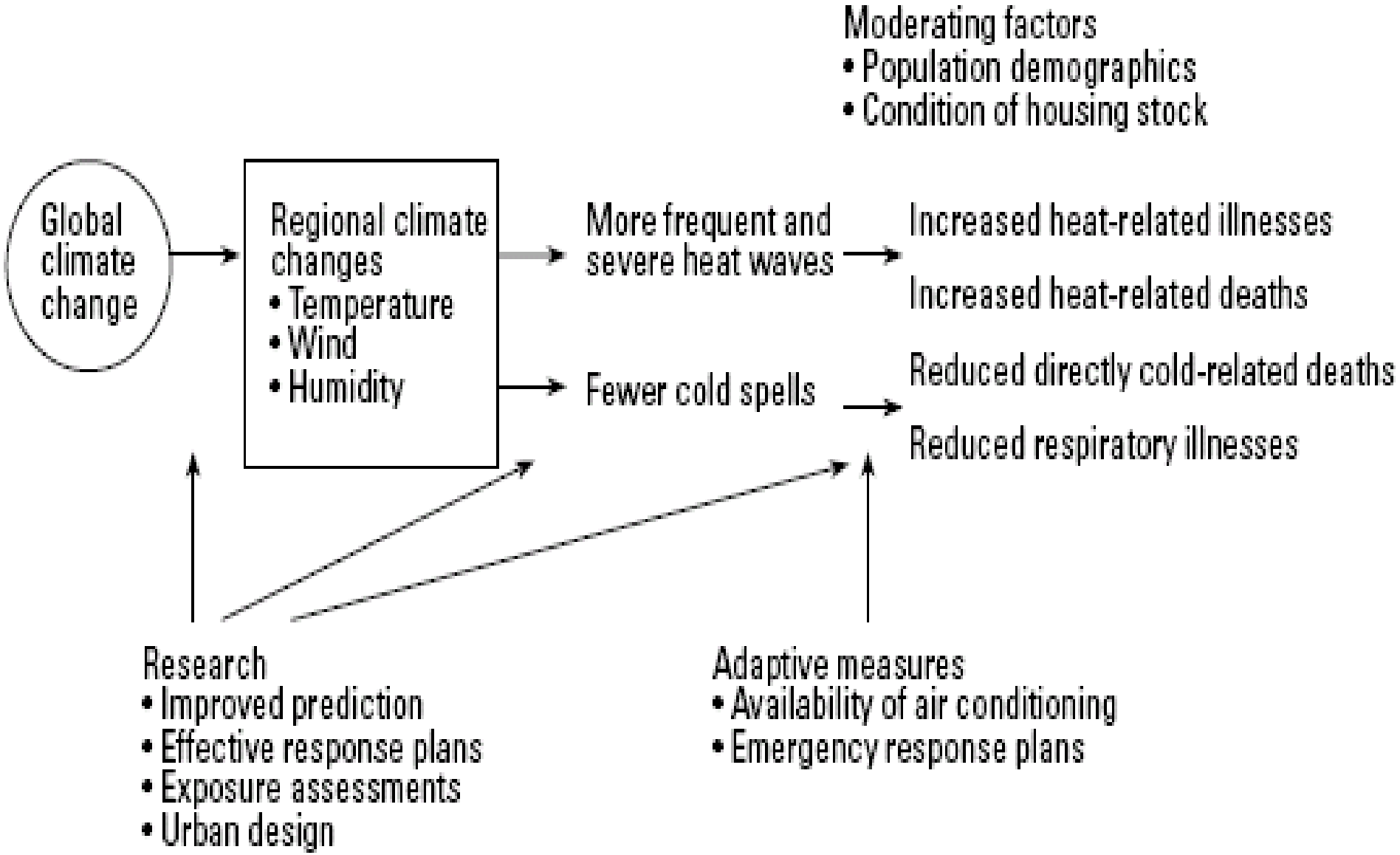


Figure 1. Projecting the influence of weather and climate change on temperature-related illnesses.

Seasonal Variation in Out-of-Hospital Cardiac Arrests in 17 United States Cities

Linda Schieb, Greg Schwartz, CDC Atlanta, GA; Bryan McNally, Emory University School of Medicine; Paul Chan, Mid-Atlantic Heart Institute; Comilla Sasson, University of Colorado School of Medicine

Background

Cardiac Arrest Burden and Outcomes

- ~300,000 out-of-hospital cardiac arrests per year in the U.S.
- Without bystander CPR, chance of survival falls 7% to 10% every minute until defibrillation
- Survival to hospital discharge is ~8%
- Survival rate has been constant for the past 30 years

Seasonal Variation in Cardiovascular Disease

- Higher rates found in winter than in summer months
  - AMI (United States[1], Greece)
  - Stroke (Australia)
  - Cardiovascular disease mortality (United States)
  - Cardiac arrest (Seattle, U.S.; Germany; Japan)

Study Objectives

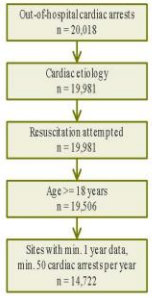
- Determine if seasonal variation exists in out-of-hospital cardiac arrests in the U.S.
- Determine if this association is maintained across various geographic locations.
- Determine the effect of temperature on seasonal variation.

Methods

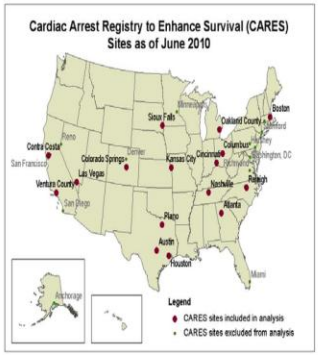
Data and statistical methods

- Cardiac arrest data from the Cardiac Arrest Registry to Enhance Survival (CARES), a partnership between the Centers for Disease Control and Prevention and Emory University.
- Up to three years of data were included for each location, ranging from January 2007 to December 2009.
- Average daily temperature data from the National Climatic Data Center.
- Poisson regression models using generalized estimating equations accounting for clustering by site were used to model the association between month or temperature and out-of-hospital cardiac arrest events.

Inclusion criteria



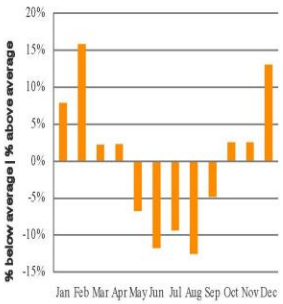
Results



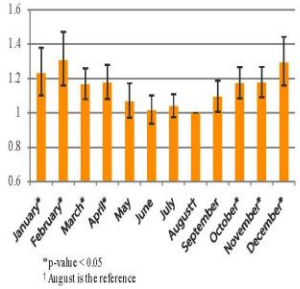
Cardiac arrest demographic data

Characteristic	N	%
Age		
18 – 54	3,912	26.6
55 - 64	3,210	21.8
65 - 74	2,907	19.7
75-84	4,693	31.9
Gender		
Men	8,900	60.5
Women	5,815	39.5
Race/Ethnicity		
White	6,071	41.2
Black	4,445	30.2
Unknown	3,037	20.6
Hispanic	807	5.5
Other	362	2.5

Cardiac arrests per day by month, percent above or below the annual daily average



Cardiac arrest rate ratio by month – all sites



*p-value < 0.05
† August is the reference

Cardiac arrest rate ratio of winter (Dec-Feb) vs. summer (Jun-Aug) for each site

Site	Rate Ratio	95% CI
Anchorage, AK	0.95	(0.66, 1.35)
Contra Costa, CA	1.41	(1.11, 1.78)
Ventura, CA	1.03	(0.77, 1.38)
Colorado Springs, CO	1.08	(0.77, 1.51)
Atlanta, GA	1.11	(1.01, 1.21)
Boston, MA	1.49	(1.19, 1.86)
Oakland County, MI	1.82	(1.39, 2.39)
Kansas City, MO	1.34	(1.13, 1.59)
Raleigh, NC	1.61	(1.29, 2.01)
Las Vegas, NV	1.12	(0.81, 1.54)
Cincinnati, OH	1.46	(1.07, 1.99)
Columbus, OH	1.37	(1.12, 1.68)
Sioux Falls, SD	2.40	(1.38, 4.17)
Nashville, TN	0.95	(0.73, 1.24)
Austin, TX	1.17	(1.00, 1.37)
Houston, TX	1.33	(1.20, 1.47)
Plano, TX	1.31	(0.80, 2.15)

Association of temperature (continuous) and cardiac arrests – Poisson regression estimate

Variable	Estimate	p value
Temperature (average daily)	-0.003	0.17

Association of temperature and cardiac arrests – rate ratio of quintiles calculated by site

Variable	Rate ratio	CI
Quintile 1 – lowest temp.	1.24	(1.18, 1.29)
Quintile 2	1.16	(1.11, 1.21)
Quintile 3	1.07	(0.99, 1.15)
Quintile 4	1.02	(0.97, 1.06)
Quintile 5 – highest temp.	Ref	

Summary

- Out-of-hospital cardiac arrests in the CARES dataset were more likely to occur in winter as compared to summer months.
- This seasonal pattern held for sites located in both northern and southern/western climates.
- Relative changes in temperature may explain some of the seasonal variation in out-of-hospital cardiac arrests.
- Temperature was associated only when comparing quintiles calculated for each location separately (e.g., the lowest temperature quintile varied from -13.8°F - 20.0°F for Anchorage, Alaska to 36.3°F - 59.0°F for Houston, Texas).

Strengths and Limitations

- Data comes from a cardiac arrest registry based on EMS and 911 reports and includes only those arrests of presumed cardiac cause in which resuscitation was attempted.
- Denominator includes total population for catchment areas as reported by individual EMS agencies.
- Data is included for locations across the U.S.

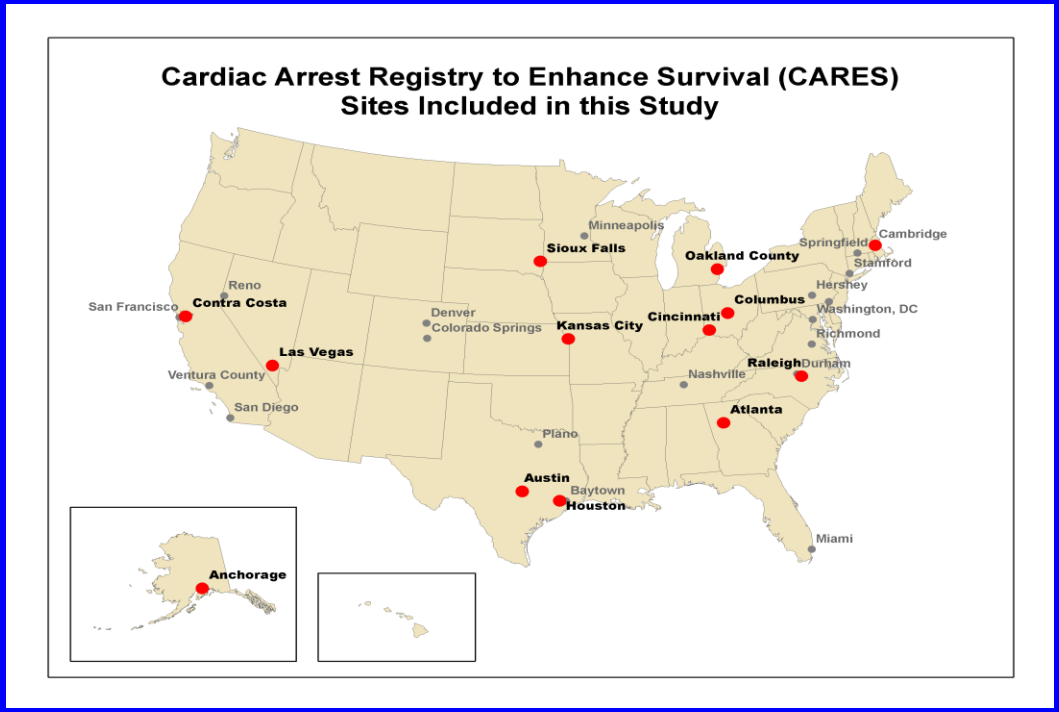
Conclusions

- Emergency response providers may need to prepare for an increase in cardiac arrest burden during winter/colder months regardless of the geographic location and climate of the area.

References

Email: cdcinfo@cdc.gov | Web: www.cdc.gov

National Center for Chronic Disease Prevention and Health Promotion
Division for Heart Disease and Stroke Prevention



Rate Ratio with 95% Confidence Intervals
Cardiac Arrest Ratio by Month

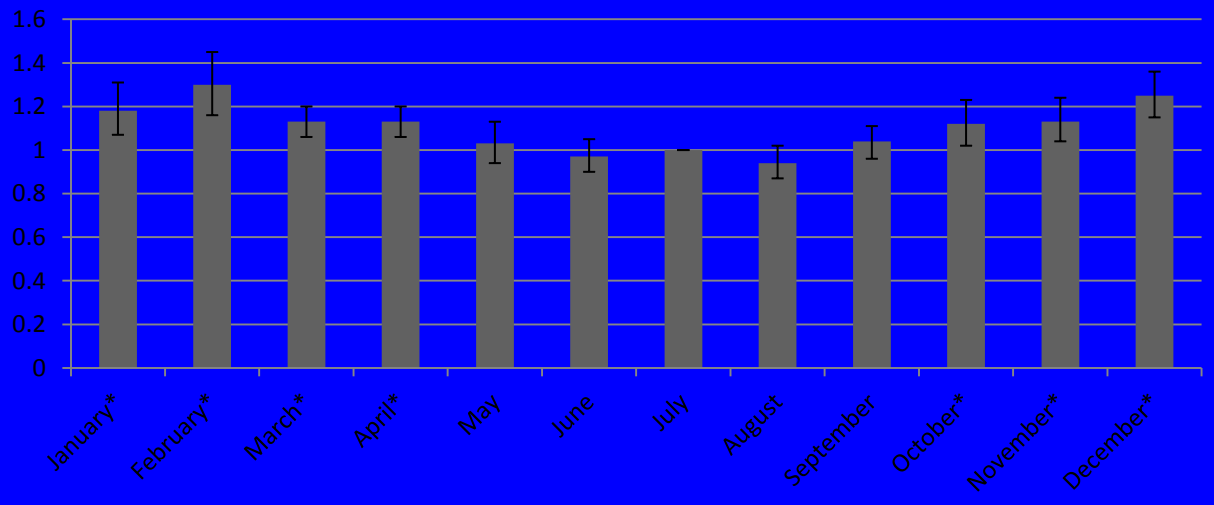


Photo by Mario Tama, courtesy Getty Images

Meteorologists are working to protect the public from weather-related health threats, such as this March storm in New York City.

Today's weather forecast calls for health

Meteorologists making links between weather, public health

Weather-Health Connections

Everyday Weather

Extreme Weather

Climate Variability/Change

Everyday
Weather&Health

UV Radiation

Cold

Take Aways & References

Main Menu

Heat

Air Quality

Bugs

Pollen &Mold

NOAA National Weather Service

A Typical Year of extreme weather events…

6 Atlantic Hurricanes

1,270 Tornadoes

5,000 Floods

10,000 Violent Thunderstorms

Drought and Large Wildfires

500 Deaths
5,000 Injuries
$14B in Losses

Climate Variability and Health Impact

Climate Variability

- Climate Variability is Predicted to Increase the frequency of EWE

Extreme Weather Events

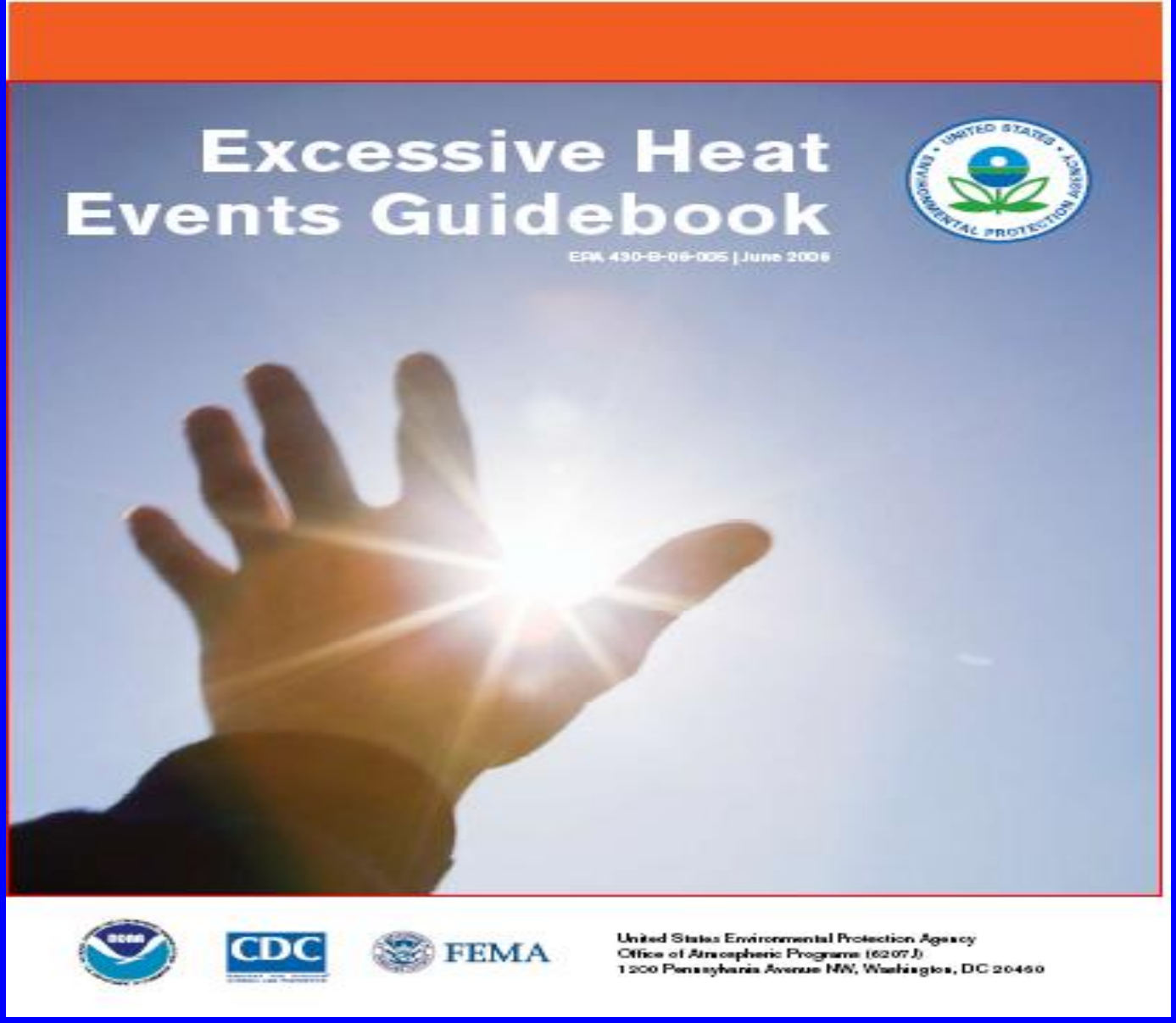
- ⏨⇧ Floods
- ⏨⇧ Tropical Cyclones
- ⏨⇧ Heat Waves

Vulnerable Populations

- Health Impact on Elderly
- ⏨⇧ Population

Older Adult US Statistics

- People 65+ represented 12.9% of population in 2009 but are expected to grow to be 19.3% by 2030.
- About 30% (11.3 million) of older persons live alone (8.3 million women, 3.0 million men).
- People 65+ account for about 36 percent of all hospital stays.



Public Health Preparedness

Health Care Delivery Preparedness & Response


11Alive.com
Extreme Weather Events
Impacting the Health Care Delivery System
Photo by Shane Durrance

Extreme Weather Events

Hospitals' Chief Complaints

Flooding

- *Disabling backup generators*

Hurricanes

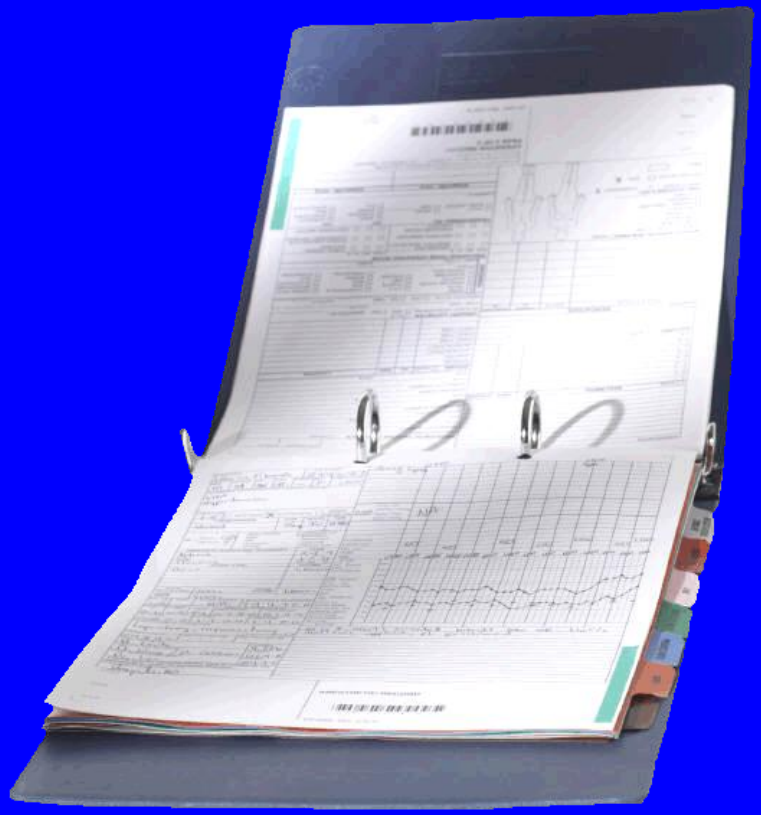
- *Surge capacity in ER*

Tornadoes

- *Power loss for high-priority patients*

Wildfires

- *Smoke entering surgical suites*



Mercy Medical Center
Summer Flood of 2008 – Sandbagging hospital at night
Cedar Rapids, Iowa

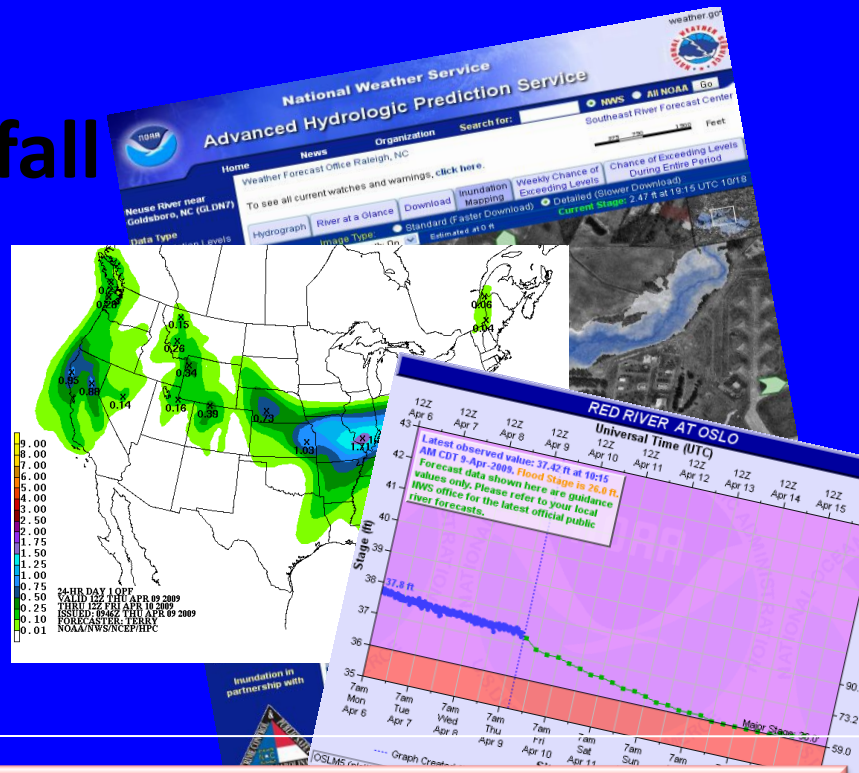

Overwhelming Support from Staff & Community

Decision Made to Evacuate

Be Prepared!

River and Flash Flooding

- Hydrographs
- QPF & Excessive Rainfall Forecasts
- Flash Flood Watches/Warnings
- River Flood Outlooks



This Will Help Your Hospital:

»Improve decisions to evacuate ALL patients

»Improve decisions to staff medical facilities prior to flooded bridges & roadways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ST. LOUIS HELICOPTER
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N350LN
EMORY FLIGHT


09/01/2005


Reliant Park
Superdome
Evacuees

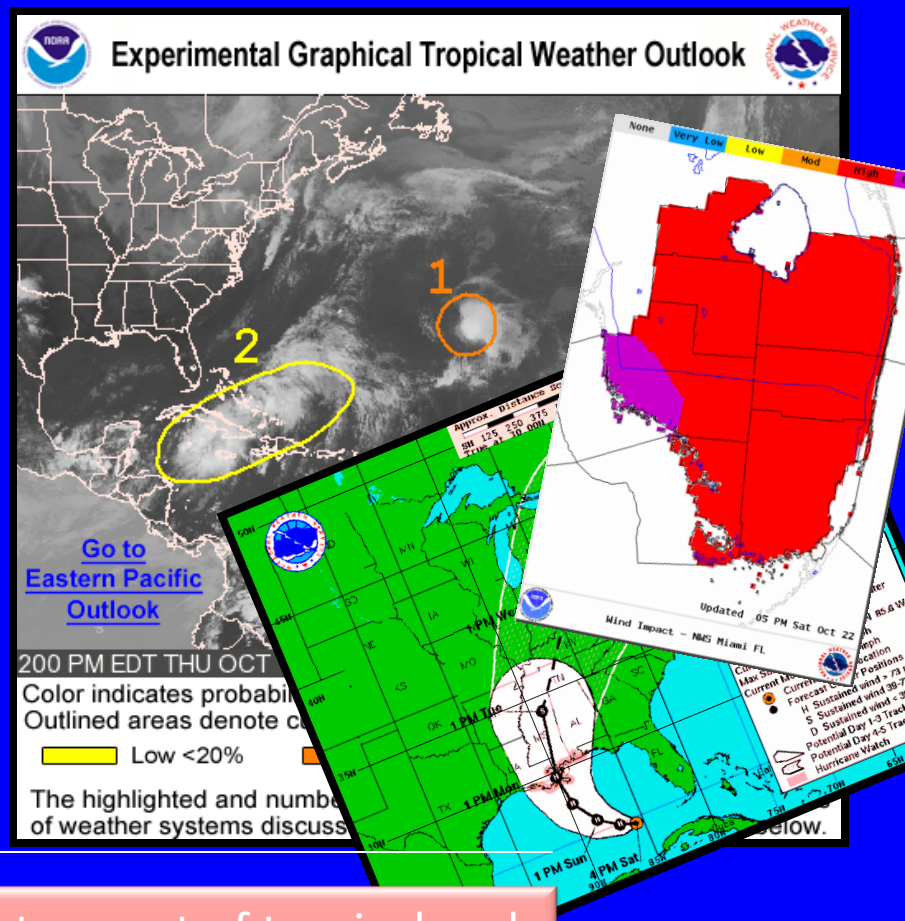
Evacuees arrive in ATL

1583 air-lifted

Be Prepared!

Tropical Storms and Hurricanes

- **Tropical Cyclone Impact Graphics**
- **NHC Outlooks, Watches, Warnings**
- **Graphical Tropical Weather Outlook**



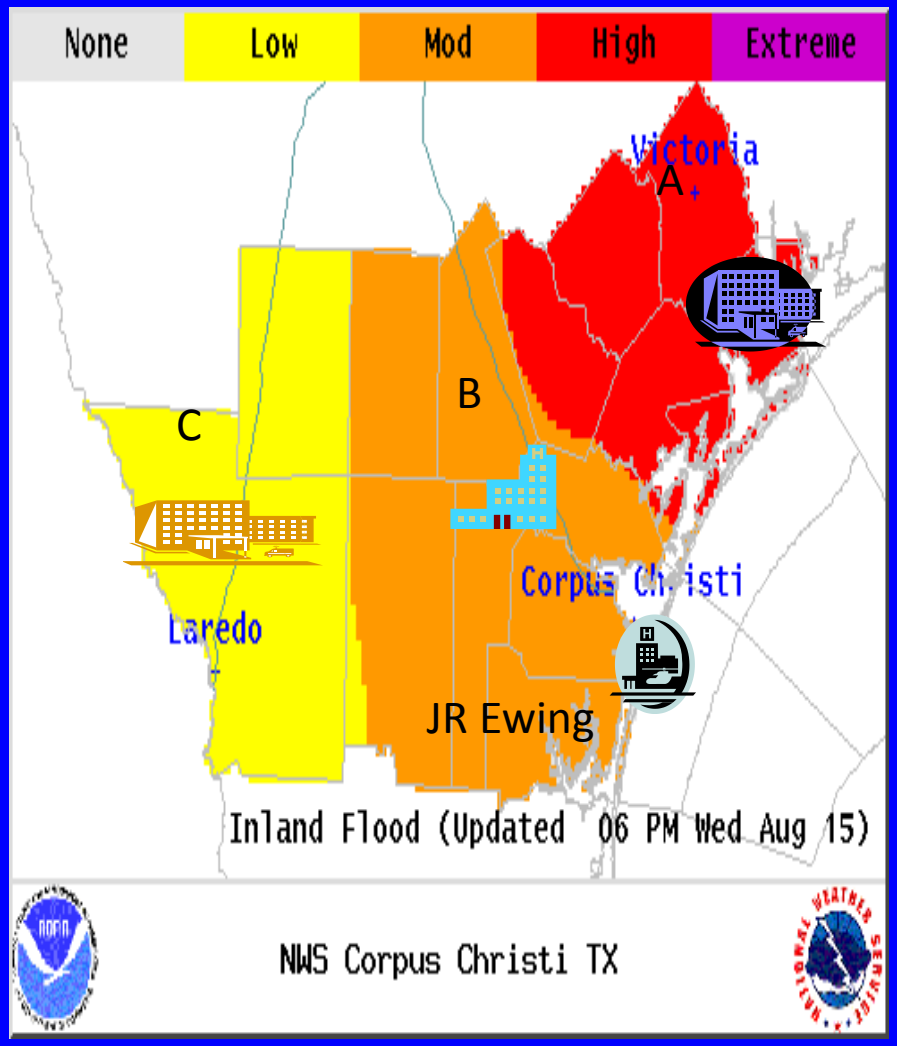
This Will Help Your Hospital:

»Improve staffing decisions prior to onset of tropical and hurricane force winds

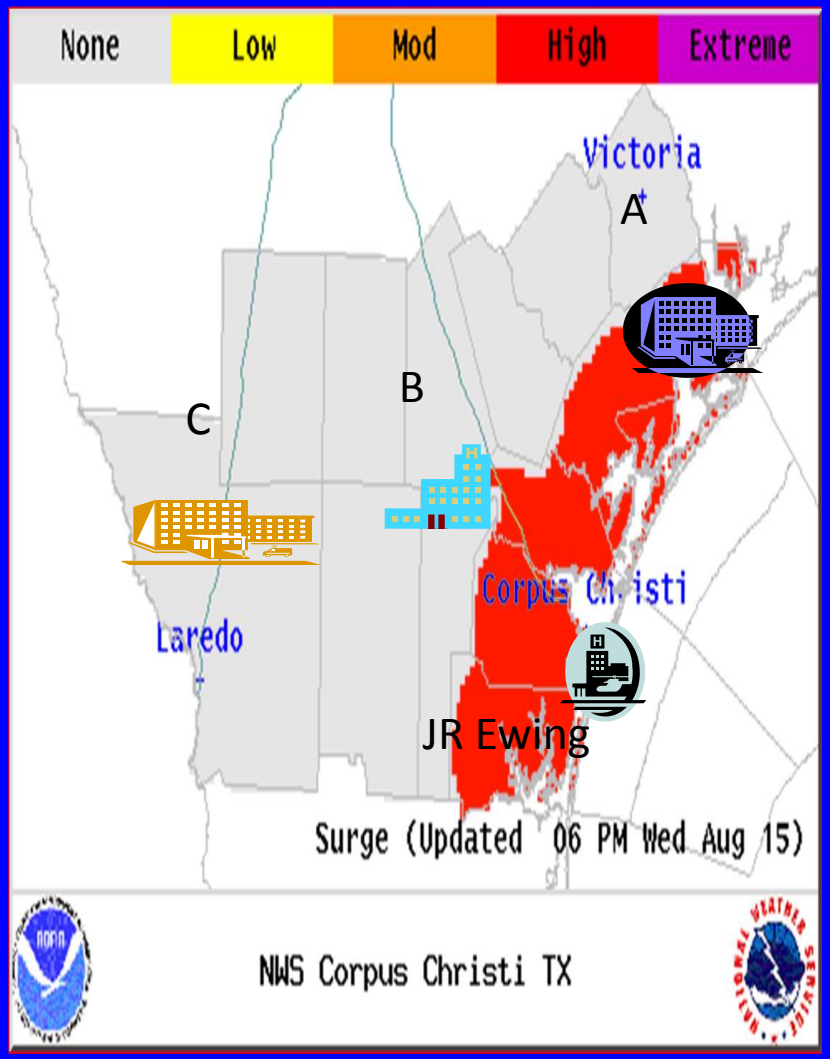
»Improve decisions to begin evacuation vs “stay in place”

Examples of New Graphics and How They Can Be Utilized

Inland Flooding Impact



Coastal Flooding Impact



http://www.weather.gov/os/tropical


FULTC
Grady Hea
Emergency Me
ADVANCED LIFE
26


Grady Memorial Hospital


GRADY HOSPITAL
Visitor Parking
Estacionamiento
de Visitantes
Receiving/
Shipping
Service
Building
Radiation
Oncology Ctr.

Sumter Regional Hospital after EF-3 tornado

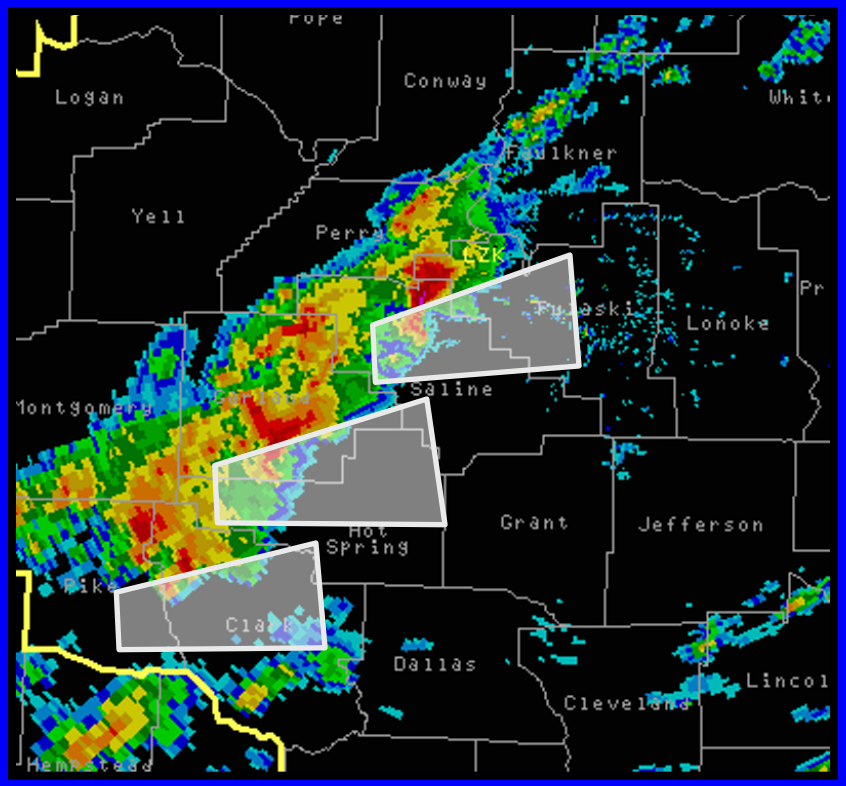
Americus, Georgia

03/01/2007

Be Prepared!

Tornadoes and Severe Thunderstorms

- **Outlooks & Watches**
- **Storm-Based Warnings**
- **Storm Spotters**



This Will Help Your Hospital:

»Improve staffing decisions before severe weather strikes

»Improve patient evacuation decisions prior to power loss

»Use NWS watches & warnings to initiate emergency plans

Senson & Sayre Fires Oct-Nov. 2008
Prov. Holy Cross & Olive View Medical Center

Wall of Fire Approaching Olive View Medical Center, Burbank, California November 2008

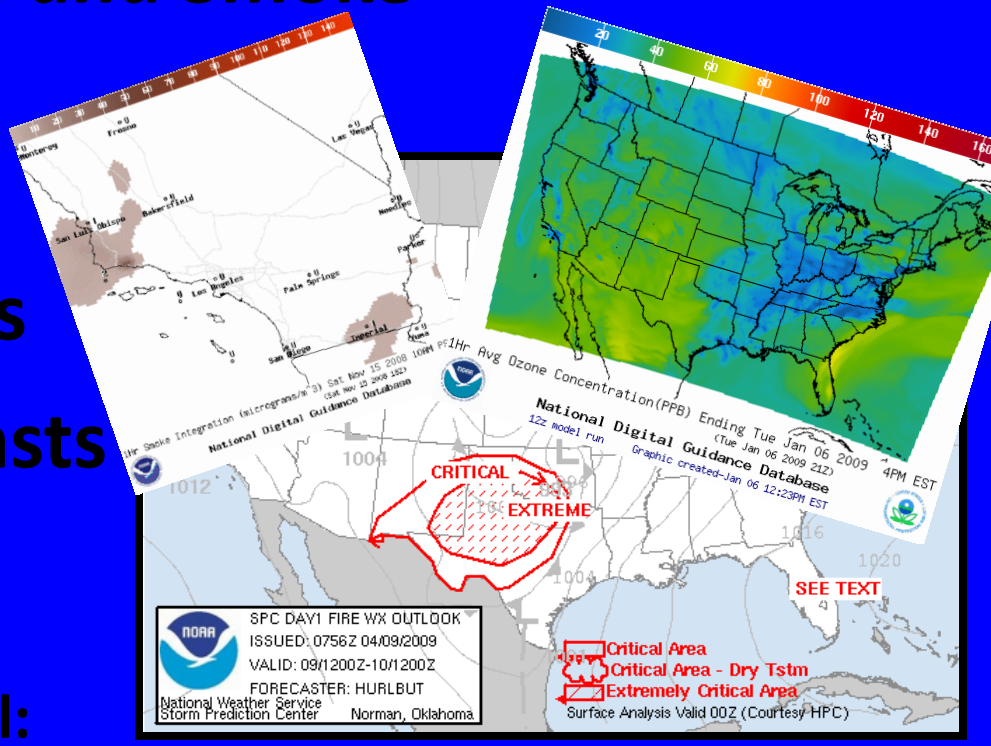
Be Prepared!
Lessons Learned

- Validate information
  - Shelter-in-place vs. evacuations
- Use N-95 masks for staff
  - Greater protection failure
- HEPA units help, especially at entrances
  - Not a long-term solution
  - Promote more N-95 usage
- Generators fail when you need them most
- If evacuation ordered, do you have a way out?
- Think “outside-the-box”
  - How do staff get to facilities when highways/roads are closed
  - Staff know alternate routes?

Be Prepared!

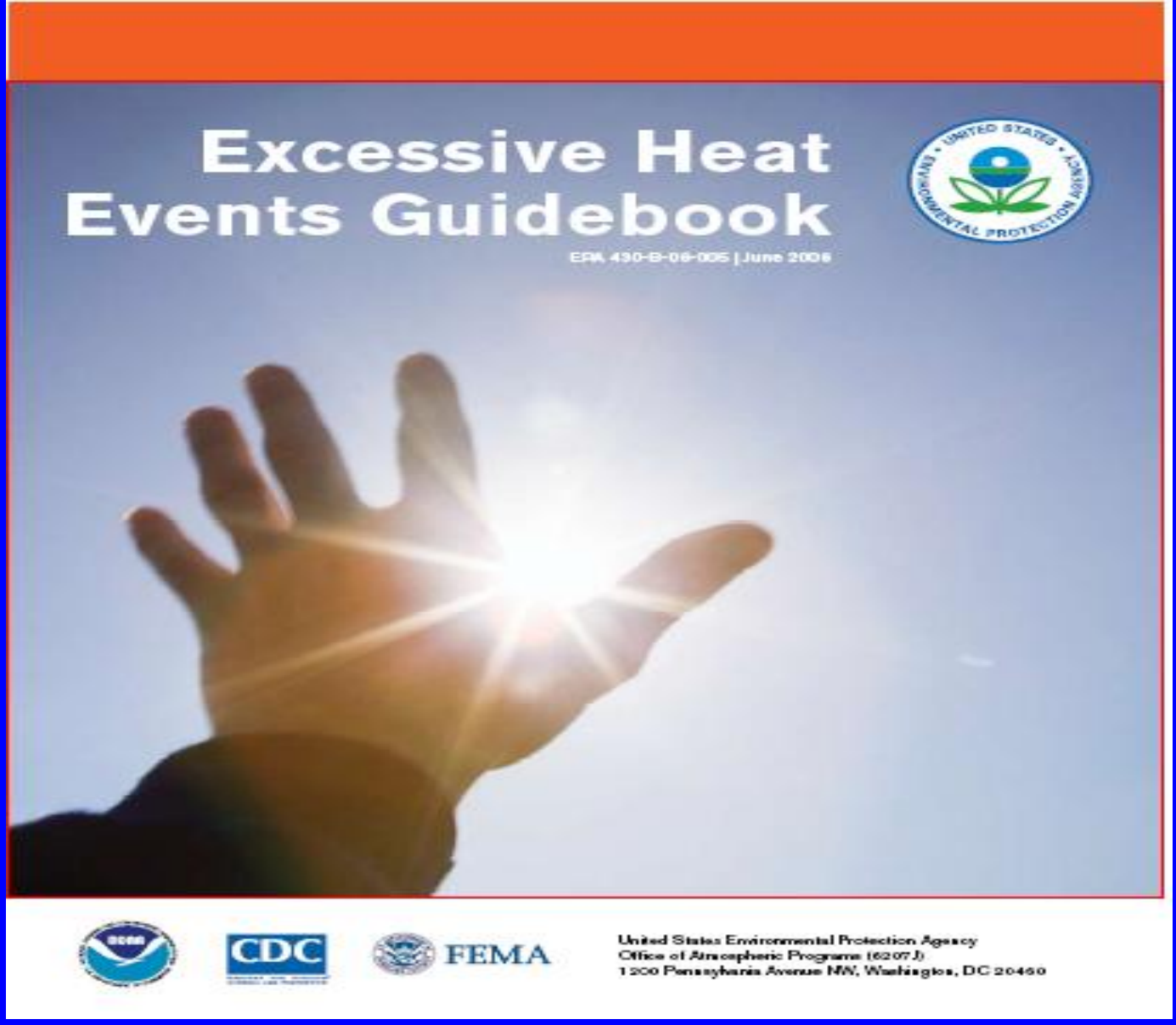
Wildfires and Smoke

- SPC Fire Weather Outlooks
- Red Flag Warnings
- Air Quality Forecasts
- Smoke Forecasts



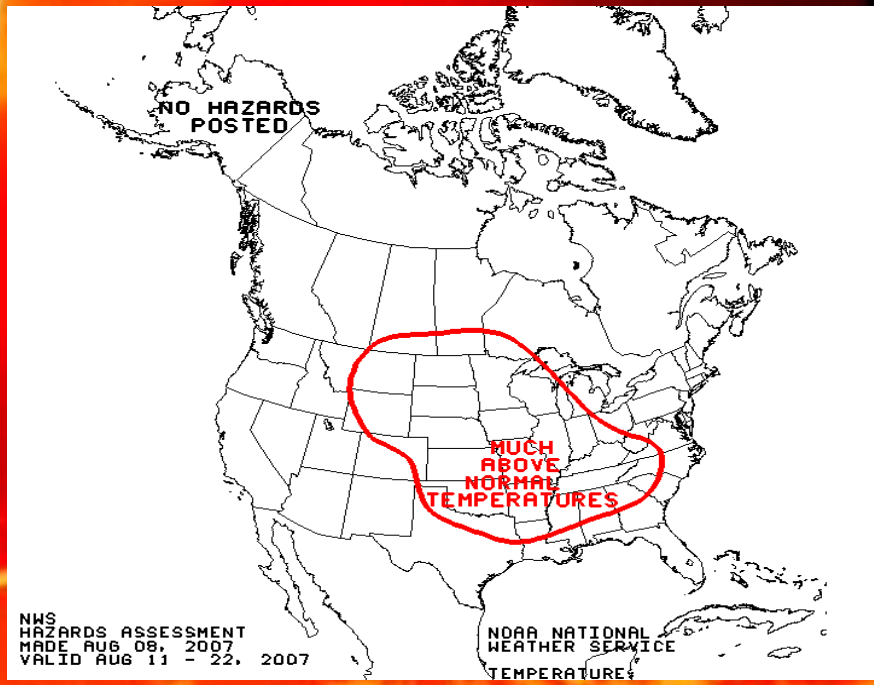
This Will Help Your Hospital:

»Improve staffing decisions before smoke affects freeways
»Improve evacuation vs. shelter-in-place decisions for medical facilities
»Improve decisions to cancel surgeries or use HEPA filters prior to smoke entering surgical suites



Public Health Preparedness for EWE

Excessive Heat Events: Preparedness for the Medical and Public Health Communities



EHE Health Impacts

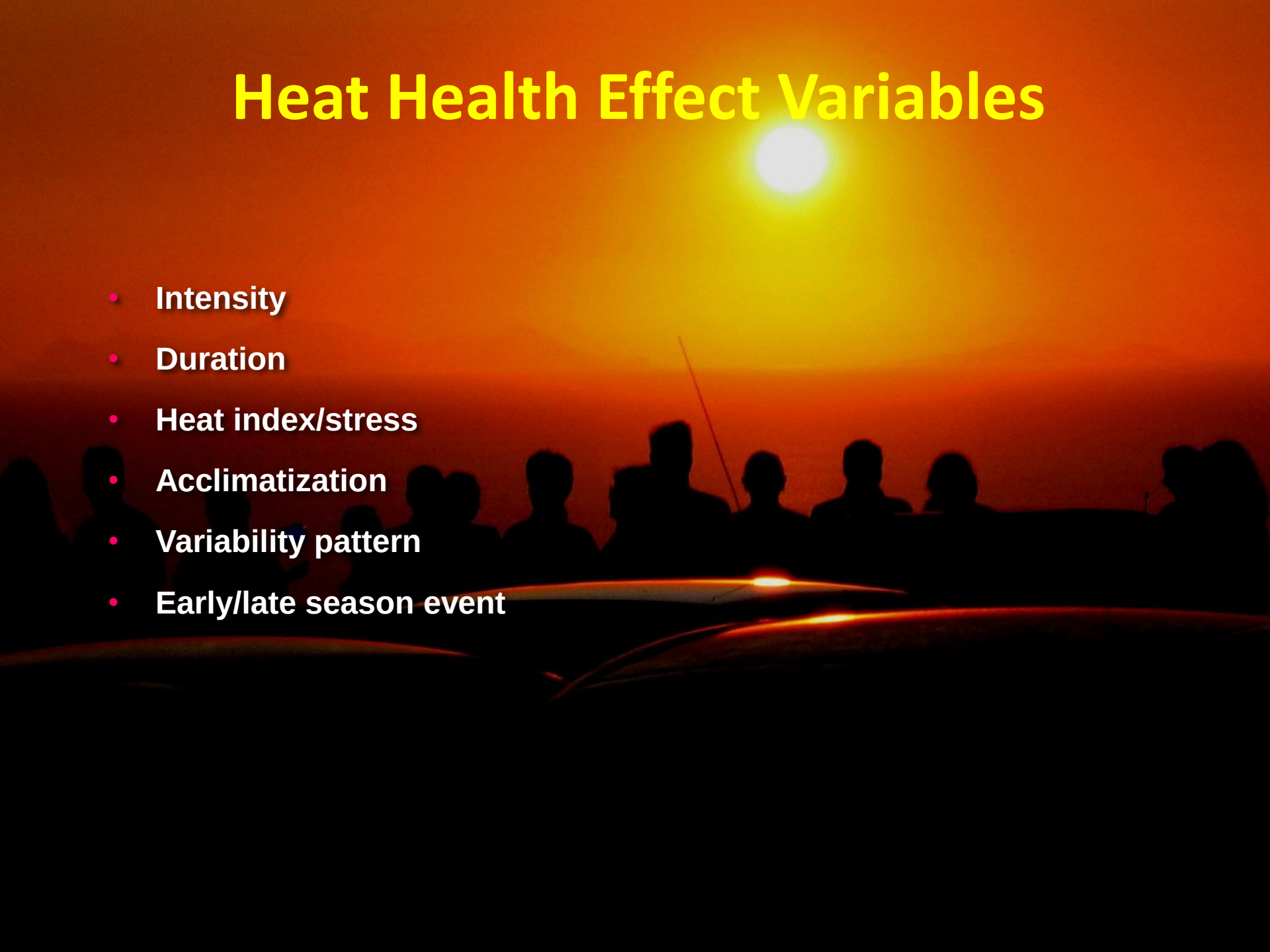
- Heat waves are responsible for more deaths than any other natural disaster annually.
- Mostly considered a ‘passive’ hazard in contrast to hurricane or tornadic activity.
- Official death tolls from heat waves are greatly underestimated as cause of death is often assumed to be from an existing condition.

Heat Health Warning System

	NWS Product	Excessive Heat Emergency Phases	*Potential Actions – All SEMS Levels*
"Heads Up"	**Statement** Informational notice that may contain general advice, observations, or weather data. Intended to heighten awareness, not notification for specific hazardous event.	**Phase I: Seasonal Readiness**	▪ Review of existing plans and procedures ▪ Basic awareness campaigns ▪ Continued collaboration and planning with stakeholders ▪ Orientation and training to plans and procedures ▪ Updating / validating notification processes ▪ Tabletop exercises, drills, etc.
"Get Ready"	**Outlook** Indicates potentially hazardous condition *MAY* develop. Provides information with considerable lead time. [May be issued *within* a Special Weather Statement] *3 - 7 Days*	**Phase II: Increased Readiness**	▪ Initial notification of key stakeholders ▪ Initial coordination call, periodic calls as needed ▪ Briefings to key stakeholders as needed ▪ Confirmation of roles, identify specific needs ▪ Increasing public information efforts ▪ Verification of use/availability of key facilities ▪ Develop, review plans and prepare staff for enhanced public outreach to most vulnerable populations
"Get Set"	**Watch** Risk of a hazardous weather has increased, but occurrence, location, and/or timing is uncertain. Intended to provide enough lead time to set plans in motion. *12 - 48 Hours*	**Phase III: Heat Alert / Standby**	▪ Daily coordination calls ▪ Initiating broader notifications ▪ Preparing for mobilization, activation of facilities ▪ Possible staging of equipment and supplies ▪ Confirm details of agency participation, staffing ▪ Finalize preparation of operation centers and staffing patterns ▪ Consider mobilizing for enhanced public outreach
	Advisory Conditions are not life-threatening by themselves, but could become life threatening if individuals do not exercise caution. *Up to 36 hours*	**NOTE:** ***Advisory OR Warning*** may be issued. (not necessarily a progression, will not be in place simultaneously)	▪ Daily Coordination Calls ▪ Increased situational monitoring and information sharing ▪ Consider partial DOC, EOC, REOC, SOC Activation ▪ May increase or make final mobilization efforts ▪ Enhanced outreach to vulnerable populations, make referrals ▪ *May move to next Phase if warranted*
"GO"	**Warning** Hazardous weather is occurring, imminent, or very high probability of occurring. *Conditions posing a threat to life or property.* *Up to 36 hours*	**Phase IV: Heat Emergency / Response**	▪ Daily coordination calls ▪ Activation of Cooling Centers ▪ Likely DOC, EOC, REOC, SOC Activations (may be Duty Officer or minimal status depending on the scope of event)

Figure 5 Chart showing the sequence of NWS heat product issuance and potential response by Santa Clara County Office of Emergency Services.

Heat Health Effect Variables



- Intensity
- Duration
- Heat index/stress
- Acclimatization
- Variability pattern
- Early/late season event

Factors that Increase Risk For EHE Related Adverse Events

Meteorological Characteristics

- Increased temperature
- Increased relative humidity
- Dry, hot winds

Demographic Characteristics

- Physical constraints (including underlying medical conditions)
- Mobility constraints
- Cognitive impairments
- Economic constraints
- Social isolation

Excessive Heat Events Guidebook, EPA June 2006

Factors that Increase Risk For EHE Related Adverse Events

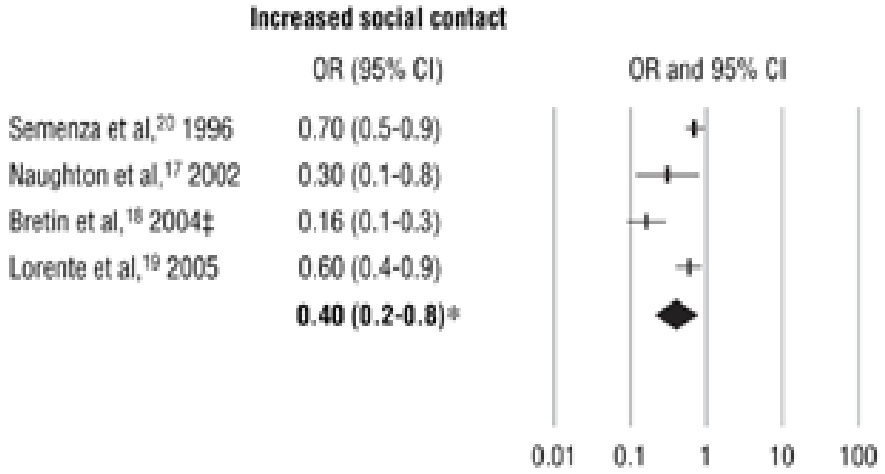
Behavioral Choices

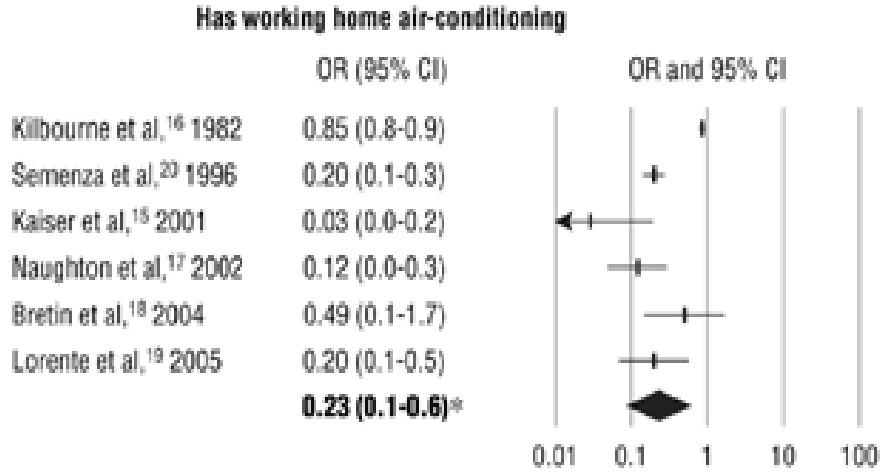
- Wearing inappropriate clothing
- Failing to stay adequately hydrated
- Consuming alcohol
- Engaging in outdoor activities
- Eating heavy and/or hot foods

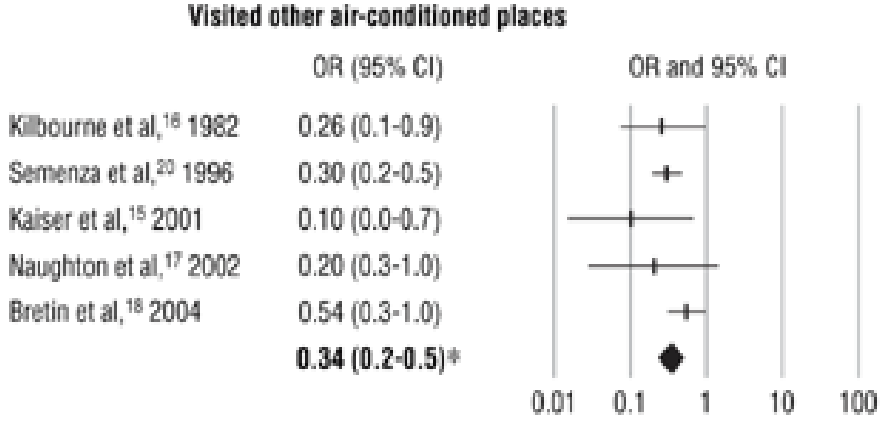
Regional Characteristics

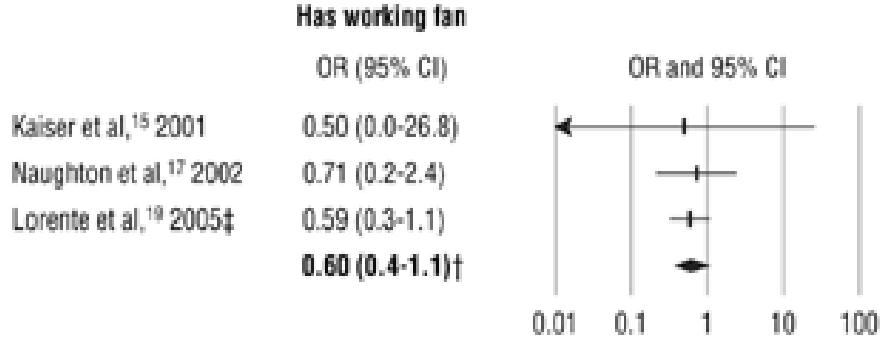
- Living in an area with a variable climate
- Living in an urban area
- Living on the upper floors of buildings

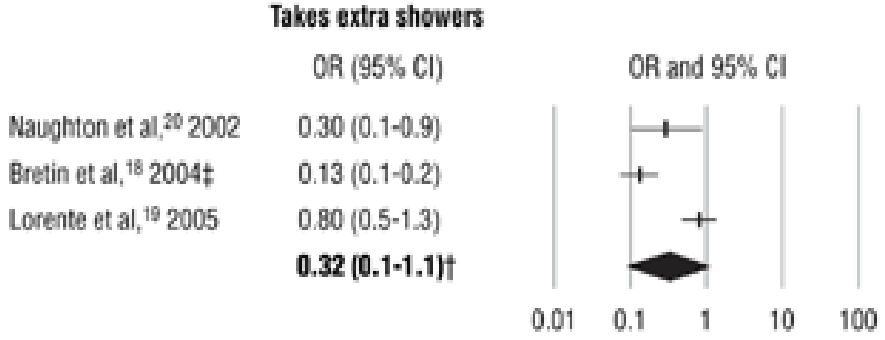
Excessive Heat Events Guidebook, EPA June 2006







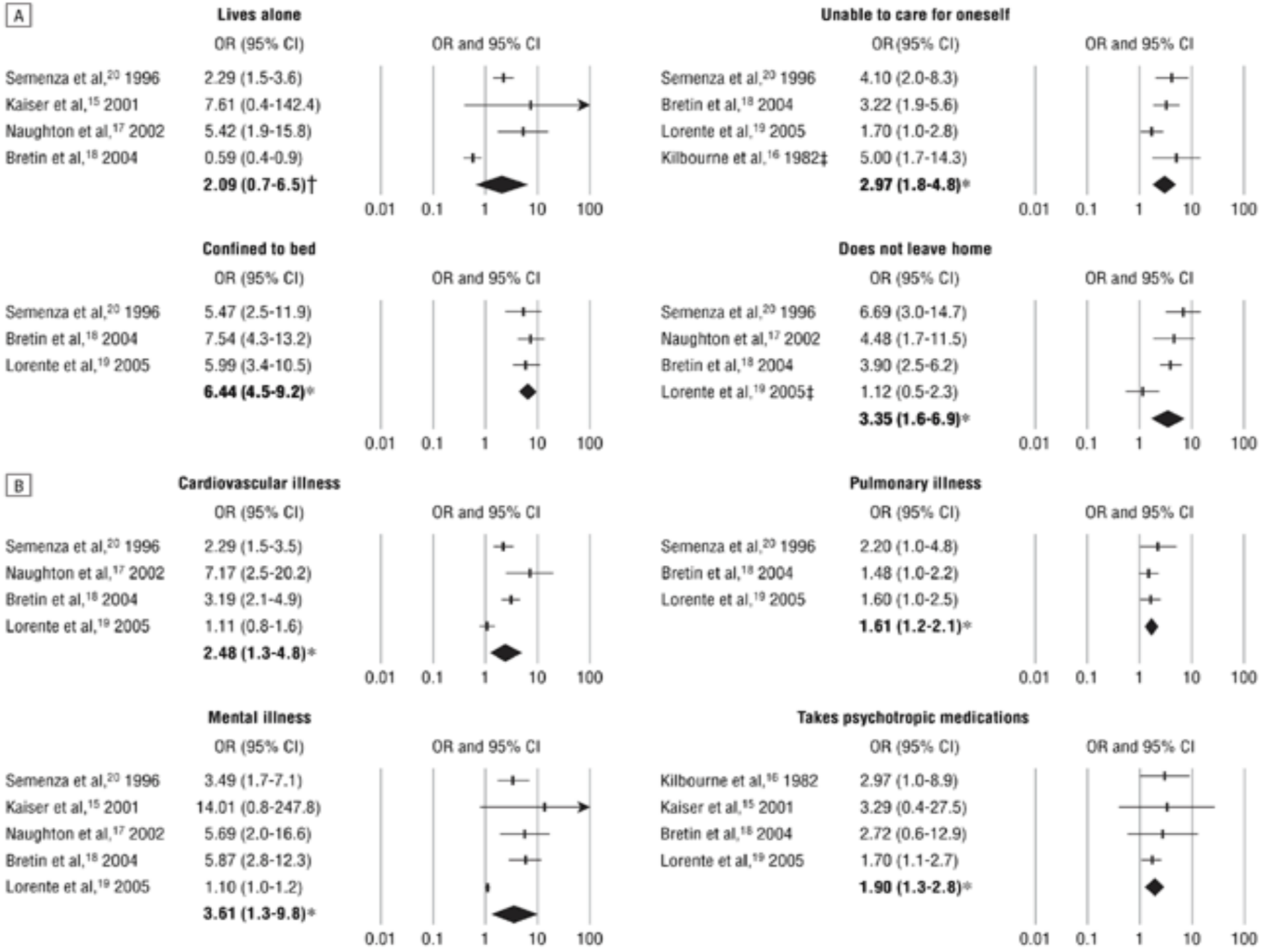




Prognostic Factors in Heat Wave Related Deaths A Meta-analysis

Arch Intern Med. **August 13, 2007**

Bouchama et al.


A
Lives alone
OR (95% CI)
OR and 95% CI
Semenza et al,[20] 1996 2.29 (1.5-3.6)
Kaiser et al,[15] 2001 7.61 (0.4-142.4)
Naughton et al,[17] 2002 5.42 (1.9-15.8)
Bretin et al,[18] 2004 0.59 (0.4-0.9)
2.09 (0.7-6.5)†
0.01 0.1 1 10 100
Unable to care for oneself
OR (95% CI)
OR and 95% CI
Semenza et al,[20] 1996 4.10 (2.0-8.3)
Bretin et al,[18] 2004 3.22 (1.9-5.6)
Lorente et al,[19] 2005 1.70 (1.0-2.8)
Kilbourne et al,[16] 1982‡ 5.00 (1.7-14.3)
2.97 (1.8-4.8)*
0.01 0.1 1 10 100
Confined to bed
OR (95% CI)
OR and 95% CI
Semenza et al,[20] 1996 5.47 (2.5-11.9)
Bretin et al,[18] 2004 7.54 (4.3-13.2)
Lorente et al,[19] 2005 5.99 (3.4-10.5)
6.44 (4.5-9.2)*
0.01 0.1 1 10 100
Does not leave home
OR (95% CI)
OR and 95% CI
Semenza et al,[20] 1996 6.69 (3.0-14.7)
Naughton et al,[17] 2002 4.48 (1.7-11.5)
Bretin et al,[18] 2004 3.90 (2.5-6.2)
Lorente et al,[19] 2005‡ 1.12 (0.5-2.3)
3.35 (1.6-6.9)*
0.01 0.1 1 10 100
B
Cardiovascular illness
OR (95% CI)
OR and 95% CI
Semenza et al,[20] 1996 2.29 (1.5-3.5)
Naughton et al,[17] 2002 7.17 (2.5-20.2)
Bretin et al,[18] 2004 3.19 (2.1-4.9)
Lorente et al,[19] 2005 1.11 (0.8-1.6)
2.48 (1.3-4.8)*
0.01 0.1 1 10 100
Pulmonary illness
OR (95% CI)
OR and 95% CI
Semenza et al,[20] 1996 2.20 (1.0-4.8)
Bretin et al,[18] 2004 1.48 (1.0-2.2)
Lorente et al,[19] 2005 1.60 (1.0-2.5)
1.61 (1.2-2.1)*
0.01 0.1 1 10 100
Mental illness
OR (95% CI)
OR and 95% CI
Semenza et al,[20] 1996 3.49 (1.7-7.1)
Kaiser et al,[15] 2001 14.01 (0.8-247.8)
Naughton et al,[17] 2002 5.69 (2.0-16.6)
Bretin et al,[18] 2004 5.87 (2.8-12.3)
Lorente et al,[19] 2005 1.10 (1.0-1.2)
3.61 (1.3-9.8)*
0.01 0.1 1 10 100
Takes psychotropic medications
OR (95% CI)
OR and 95% CI
Kilbourne et al,[16] 1982 2.97 (1.0-8.9)
Kaiser et al,[15] 2001 3.29 (0.4-27.5)
Bretin et al,[18] 2004 2.72 (0.6-12.9)
Lorente et al,[19] 2005 1.70 (1.1-2.7)
1.90 (1.3-2.8)*
0.01 0.1 1 10 100

EHE Health Impact
Vulnerable Populations

- Highest risk are the elderly, infirm, very young, the chronically ill, the homeless, the mentally ill, the overweight and those dependant on alcohol or drugs.

EHE Health Impact
Health Care Institutions

- Increase in hospital admissions
- Need for additional staff
- Increased demand for medical supplies
- Need for equipment suitable for use with overweight and older people
- Overcrowding of healthcare facilities

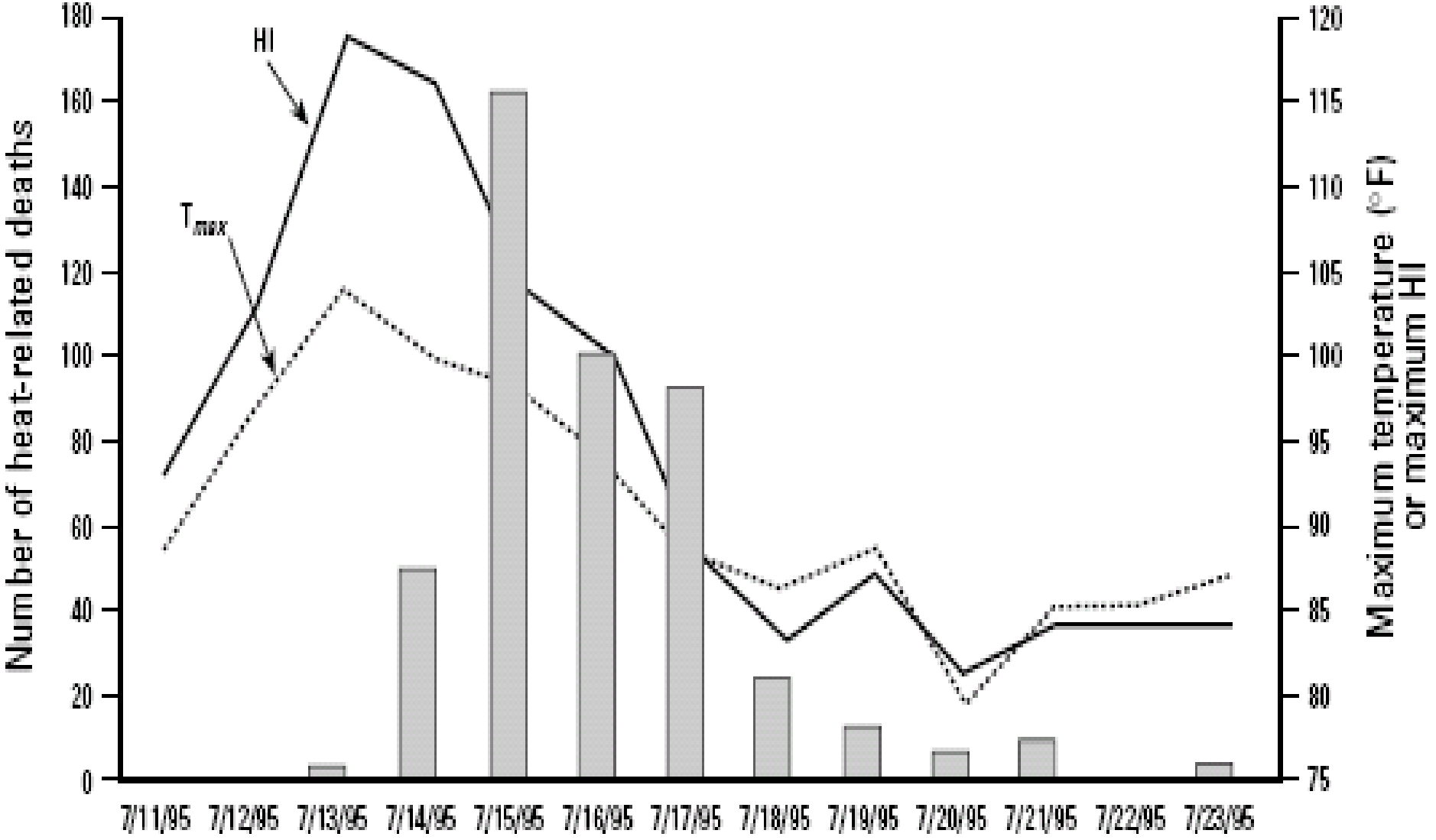
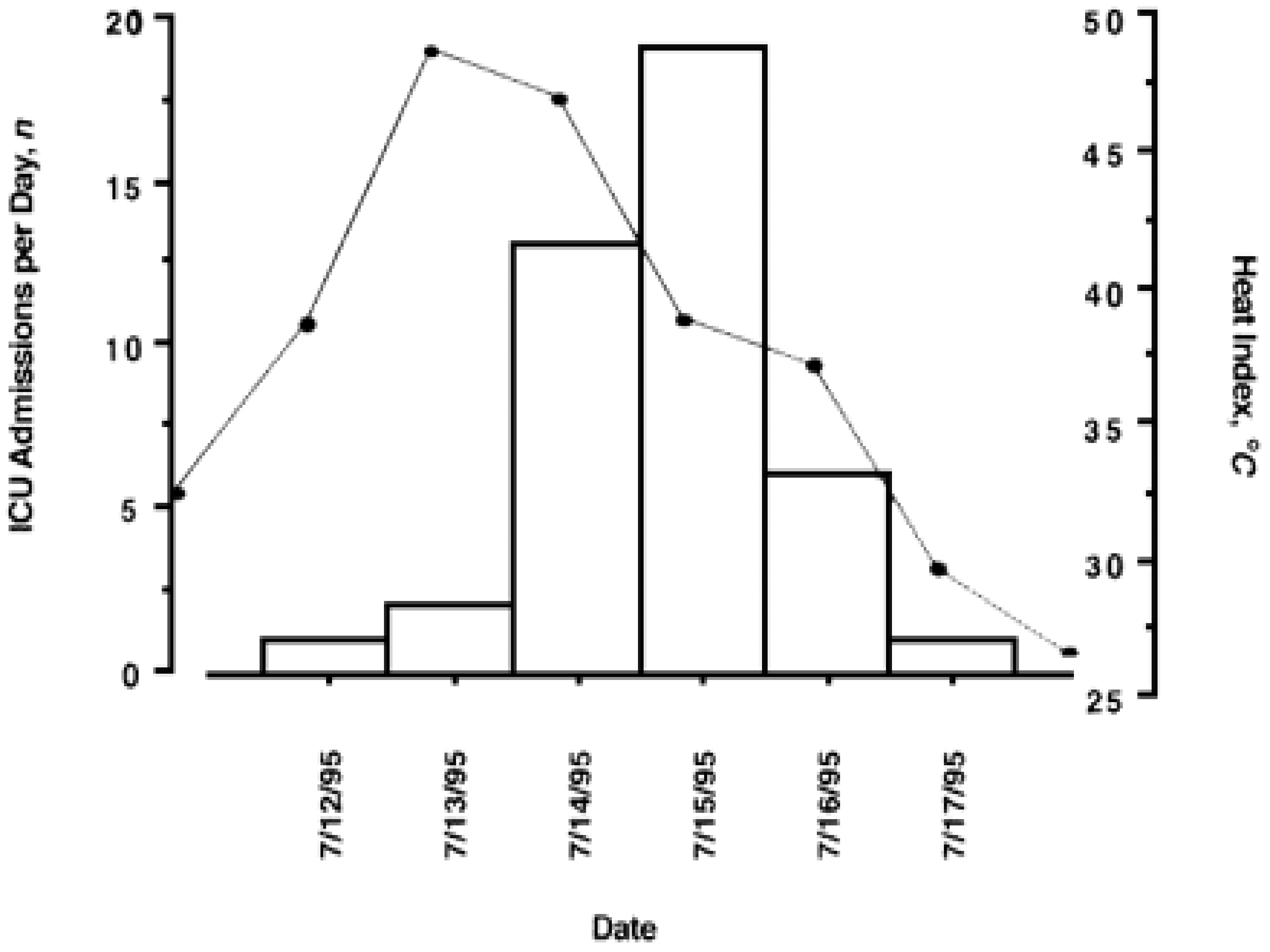
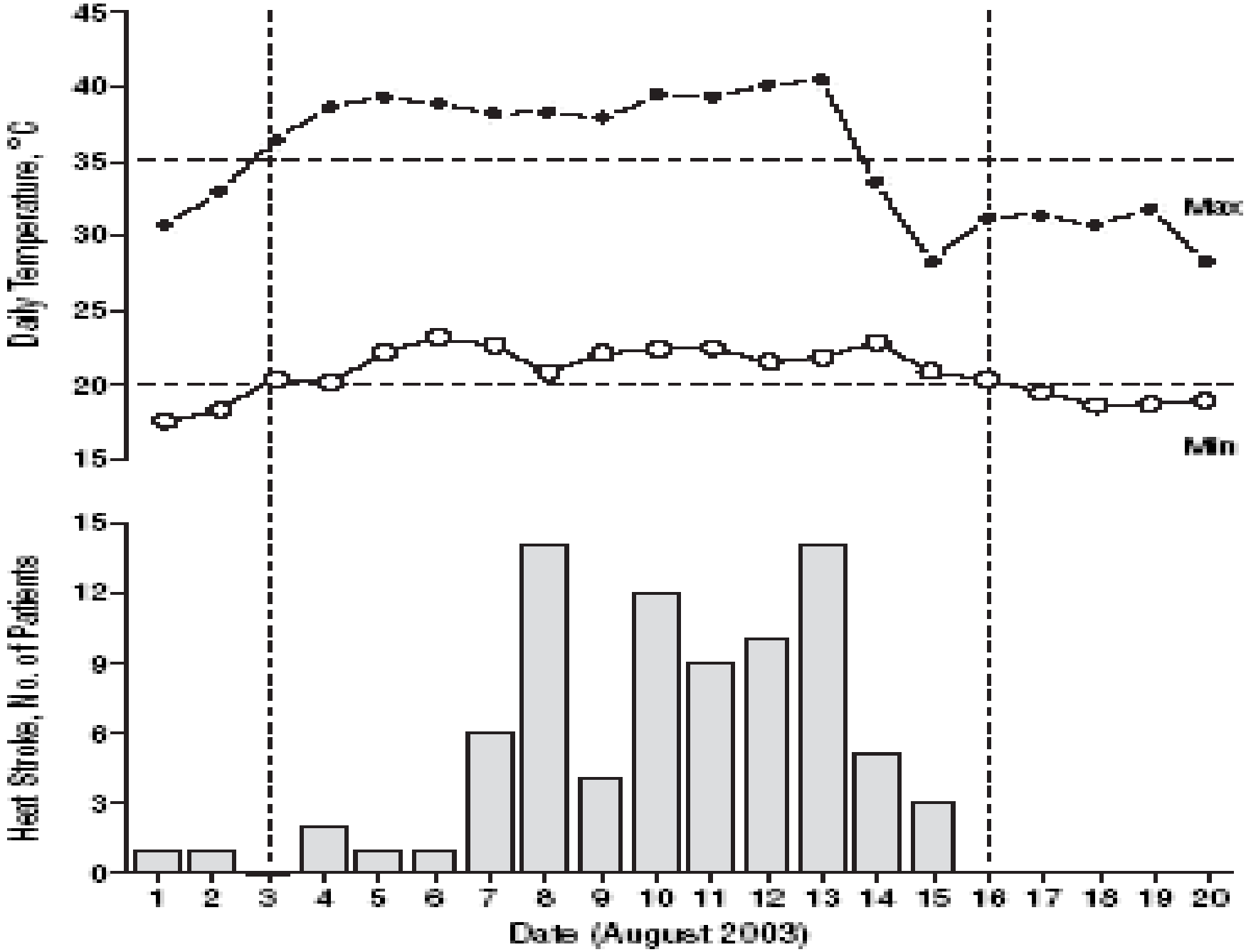


Figure 2. Relationship of HI to heat-related deaths, showing probable cause and effect and a lag time of approximately 2 days, Chicago, 11–23 July 1995. Data from the National Oceanic and Atmospheric Administration (47).


ICU Admissions per Day, n
20
15
10
5
0
Heat Index, °C
50
45
40
35
30
25
7/12/95
7/13/95
7/14/95
7/15/95
7/16/95
7/17/95
Date


Daily Temperature, °C
45
40
35
30
25
20
15
Max
Min
Heart Stroke, No. of Patients
15
12
9
6
3
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Date (August 2003)

Killing Heat Editorial
Kellermann and Todd July 11, 1996

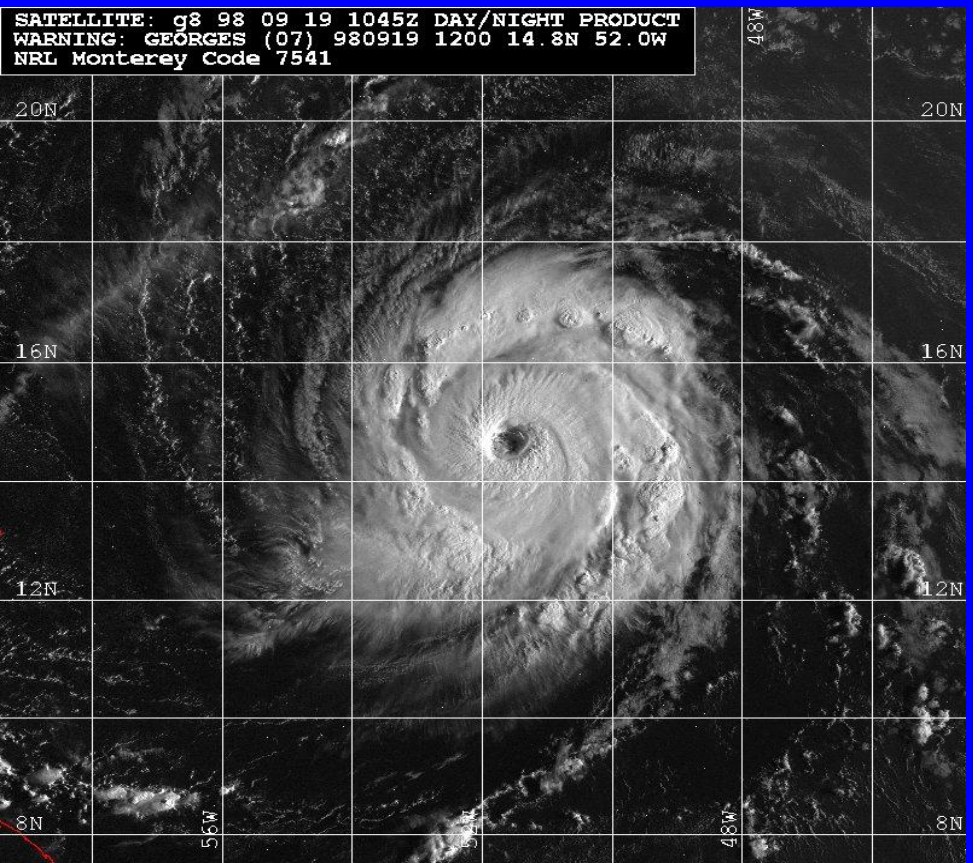
- "Although heat stroke is amenable to medical treatment, control can be best achieved by applying the principles of public health,"
- "Sentinel surveillance, public education, outreach to vulnerable individuals, and enlisting the help of the entire community can save lives.“
- “Heat stoke is preventable”

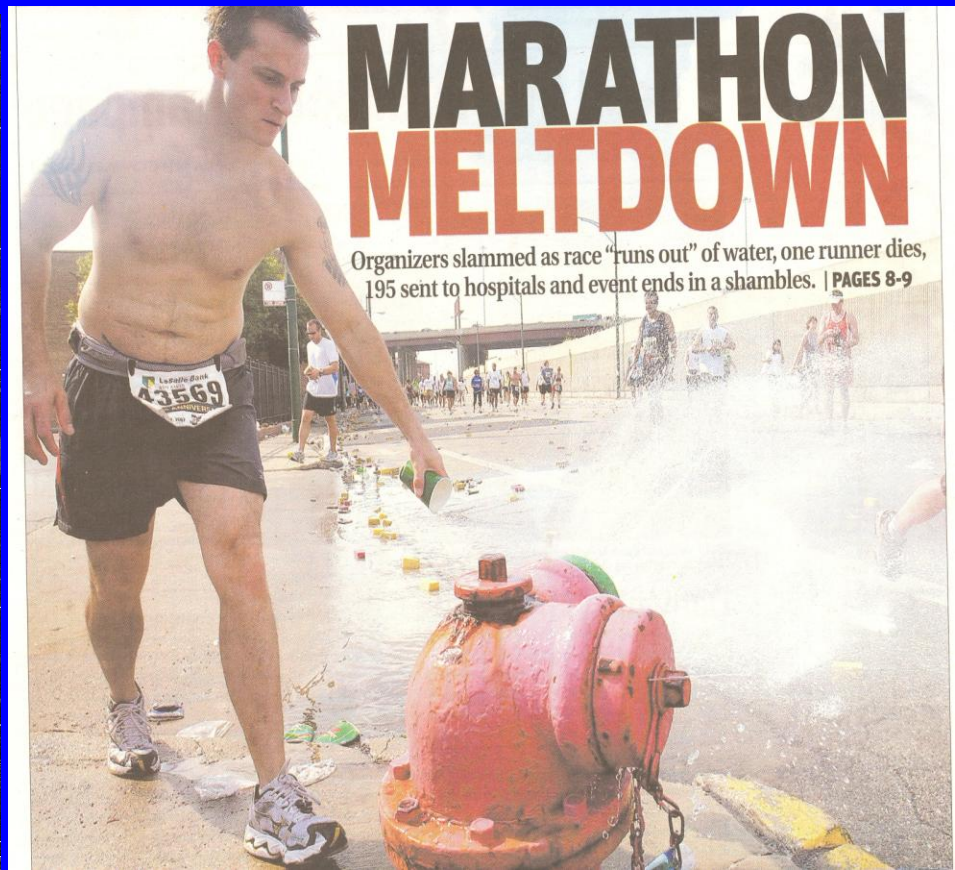
Emergency Response Planning

FEMA “All Hazards" approach. Community Planning

- This recommended approach is effective because while the causes of emergencies may vary greatly, the effects of emergencies do not.
- Many of the same tasks apply to multiple types of emergencies and disasters.
- For example, the communication role with the public around infectious disease prevention may be the same for weather disasters and suspected Bioterrorism events.

The health impacts and adaptive measures needed to respond to a regional drought - urban marathon EHE - or hurricane affected community - although different would all benefit from planning with an “all hazards approach”.





Preparing
Makes Sense for
Older Americans.
Get Ready
Now.

READY.GOV

From The U.S. Department of Homeland Security

Ready

Prepare. Plan. Stay Informed.

FEMA Get Ready Campaign ✔
Individual Preparedness Planning

- Get a Kit
- Make a plan
- Be informed

KEY MESSAGES

- More extreme weather events
- Increase in heat, respiratory and water related illness and death
- Elderly disproportionally effected both inside and outside the hospital.
- Community preparedness plan should involve health care delivery and public health providers with local NWS warning coordinating meteorologist.
- Elderly need to have an individual preparedness plan.
- All disasters are local.

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